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Performance evaluation of frontline demonstration of zero tillage technology in wheat under semi-irrigated conditions

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Abstract
Present study was conducted by Krishi Vigyan Kendra Bhatapara for performance evaluation of frontline demonstrations on sowing of wheat by zero tillage method at farmers' field during years 2017-18, 2018-19 and 2019-20 in Bhatapara and Balodabazar block of the district Balodabazar-Bhatapara of Chhattisgarh state with size of trial is 0.4 ha each farmers to determine the impact of sowing techniques on yield of wheat under farmers conditions. For this purpose, the trail was conducted in treatments namely flat-bed method by broadcasting and line sowing by zero till. The data on productivity, economics and water saving in demonstrated plots were calculated and compared with the corresponding farmer's practice. It was observed that yield of demonstrated plots was 9.37 per cent higher than farmer's practices. The extension gap, technology gap and technology index were 3.63 q ha^{-1}, 4.58 q ha^{-1} and 9.75 per cent, respectively. Due to reduced cost of cultivation and higher crop yield, the gross and net return was also higher in zero tillage as compared to the farmer's practice. The BCR was 2.71 in zero tillage, which was higher than in farmer's practice (2.19). The depth of irrigation was also less, i.e., 22.27 ha-cm and 30.97 ha-cm in zero tillage and farmer's practice, respectively. Higher yield and returns due to reduced cost of cultivation and water saving in the FLDs over the farmer's practice created greater awareness and motivated the other farmers to adopt this latest wheat sowing technology.

Keywords: Zero tillage, wheat, yield

Introduction
India is second largest producer of wheat (*Triticum aestivum* L.) in the world after China (134.34 million tonnes) with about 12% share in total world wheat production. In India, wheat is grown on about 30.60 million hectare area with a production of 98.38 million tonnes and average productivity is 3216 kg ha^{-1} during 2016-17 (Anonymous, 2017) [1] and it is a second most important staple food after rice. In Chhattisgarh wheat occupies 180.38 thousand hectares with a production of 279.59 thousand tonnes and average productivity is 1550 kg ha^{-1} during 2017-18 (Anonymous, 2018) [2]. The yield and quality of wheat grain is influenced by several factors such as soil, climate, variety, sowing method, sowing time, sowing depth, seed rate, water & nutrient management, weed, insect & disease management, harvesting time and other agronomic practices etc.

The delay of every successive day in planting beyond November third week decreases the grain yield. Therefore, to avoid delay in planting and reduce the cost of production, farmers have started adopting resource conserving technologies such as zero tillage and surface seeding in wheat production (Gupta and Seth, 2007) [3]. Savings in input cost, fuel consumption and irrigation water-use have been reported due to the adoption of zero tillage in wheat cultivation Malik *et al*. (2003) [4].

Despite the documented positive agronomic, economic and environmental impacts, conservation tillage under wheat has not yet become widely popular in many parts of Balodabazar-Bhatapara district of Chhattisgarh state. For its horizontal expansion, it was planned to conduct front line demonstration of this innovative sowing method. The present study has been undertaken with the objectives to study the differences between demonstrated packages of practices vis-à-vis practices followed by the local farmers (farmers' practices) in terms of extension gaps/technology gaps.

Materials and Methods

Frontline demonstrations (FLD) were conducted for three consecutive years during rabi seasons at farmer's fields. The average annual rainfall of Balodabazar-Batapara district was 1100 mm annually. Study was carried out during rabi 2017-18, 2018-19 and 2019-20 on thirty eight farmer's field of Bhatapara and Balodabazar block of district Balodabazar-Bhatapara of Chhattisgarh state with size of trial is 0.4 ha to determine the impact of sowing techniques on yield of wheat under farmers' conditions. The conventional rice-wheat rotation was being followed on the field from last 15 years. Wheat seed and zero tillage seed drill was supplied as critical input for partial fulfilment and other inputs were applied as per the recommendation and wheat variety GW - 273 was most commonly grown at their fields. The sowing of wheat was done during 10th November to 15th November in zero tillage, whereas it was sown from 25th to 05th December in conventional tillage (farmer's practice) and harvested during mid of April. The total of 13 frontline demonstrations in 5.2 ha was conducted every year at farmers' field in different villages of district Balodabazar-Bhatapara of Chhattisgarh State. Along with frontline demonstrations (FLD), practicing farmer training on calibration, operation and maintenance of zero tillage seed drill was also imparted. All fertilizers were drilled at the time of sowing in demonstrated fields, whereas, it was broadcast in farmers' practice. Two irrigations were given to crop in zero tillage, while in addition to this three irrigation in conventional tillage fields, one pre-sowing irrigation was also given.

Table 1: Details of wheat grown under FLD and farmer practice.

Sr. No.	Particular	Frontline demonstration	Farmer practice
1	Variety	GW-273	GW-273
2	Seed rate (kg/ha)	100	120
3	Seed treatment	Carboxin+ thiram @ 2 g/kg seed	No
4	Sowing method	Zero tillage sowing after harvesting of paddy	Conventional tillage *i.e.* 2 disking + 2 cultivator + 2 planker + seed drill + planker
5	Sowing date	10th to 15th November	25th November to 05th December
6	Fertilizer application N:P:K (kg/ha)	120:60:40	175:25:0
7	Weed control	Less emergence and easy to control through single application of weedicide	More emergence and difficult to control even with higher doses of weedicides
8	Plant protection measures	Need based spray of insecticides and fungicides	Over dose/ un recommended brands of insecticides and fungicides

The farmer practices were maintained in case of local check. The data were collected from both improved practices as well as farmer practices and finally the extension gap, technological gap, technological index along with the benefit-cost ratio were calculated (Samui *et al.*, 2000) [7]. The data output were collected from both FLD plots as well as control plot and finally the extension gap, technological gap, technological index along with the benefitcost ratio were calculated. (Samui *et al*., 2000) [7] as given below.

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension gap} = \text{Demonstration yield} - \text{Farmers yield}$$

$$\text{Technology index} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}}$$

Results and Discussion

Grain Yield

The crop from all the plots was harvested under the supervision of the KVK scientists. The yield from both the plots i.e., demonstration and farmers' practices were compared and it was evident that an average yield of demonstrated plots was 9.37 per cent higher than that of farmer's practices (Table - 2). The grain yield under demonstrated plots were 42.25, 42.60 and 42.40 q ha^{-1} with an average of 42.42 q ha^{-1} from the year 2017-18, 2018-19 and 2019-20. However, it was 38.35, 39.20 and 38.80 q ha^{-1} with an average of 38.78 q ha^{-1} under farmer's practice. The highest increase in grain yield (10.17%) was observed in the year 2017-18. The reasons behind the increase of yield under demonstrated plots might be due to timely sowing and adoption of other recommended technologies about which the farmers were ignorant. Meena *et al.* (2016) [5] also observed the higher wheat yield in zero tillage as ZT wheat farmers could sow the crop much earlier than their conventional counterpart and early sowing is associated with higher yield, a significant and positive yield impact (Increased by 9.37%) observed in the study area. In southeastern conditions of Turkey conditions, it has been found that no tillage had resulted into lowest fuel consumption and maximum field efficiency and concluded that and corn can also be sown after lentil with conservation tillage and direct seeding Sessiz *et al.* (2010) [8].

Extension Gap

An extension gap between demonstrated technology and farmers practices was also calculated and on an average basis, the extension gap of 3.63 q ha^{-1} calculated (Table - 2). This gap might be attributed to the adoption of improved technology practices such as proper seed rate, use of seed treatment material, nutrient management, pest management etc. in demonstrated plots which resulted in higher grain yield than the traditional farmers, practices. On the basis of the extension gap, the farmers were motivated to adopt the recommended package of practices to reduce the extension gap and to increase their grain yield. Technology Gap The technology gap was calculated by deducting the demonstrated plot yield from the potential yield of the wheat crop. The recorded technology gap was 4.75, 4.40 and 4.60 q ha^{-1} during the study period. The average technology gap was found 4.58 q ha^{-1}. The difference in technology gap during two years could be due to more feasibility of recommended technologies like sowing time, seed rate, seed treatment, nutrient management and plant protection measures especially IPM. Higher technology index reflected the inadequate proven technology for transferring to farmers and insufficient extension services for transfer of technology.

Economic Analysis and Water Saving

The cost of cultivation (R ha^{-1}) during the year 2017-18, 2018-19 and 2019-20 was 30430 R, 31340 R and 31590 R respectively in zero tillage sown wheat. While it was 34570 R, 35250 R and 35680 R in conventionally sown fields (Table - 3). Particularly in conventional sowing due to more number of tillage operations, the average higher cost of cultivation in conventional sown field was 4047 R ha^{-1}. Due to reduced cost of cultivation and higher crop yield, the gross and net return was also higher in zero tillage as compared to the conventional sowing. The BCR was 2.55, 2.68 and 2.89 in zero tillage, which was higher than in conventional sowing 2.04, 2.19 and 2.34, respectively. On waterfront, zero tillage technology consumes less water as one pre-sowing irrigation does not require. In addition to this during the average time for irrigation were 7.50 h ha^{-1} and 9.30 h ha^{-1} in zero tillage and conventional sowing respectively. Consequently, the depth of irrigation was also less in zero tillage as compared to conventional sowing i.e., 22.27 ha-cm and 30.97 ha-cm, respectively in zero tillage and conventional sowing. Raju *et al.* (2012) [6] and Tripathi *et al.* (2013) [9] also reported saving in input cost and irrigation water use in zero tillage wheat cultivation.

Table 2: Grain yield and gap analysis of FLDs and farmer practices

Year	Yield (q ha^{-1})		Change in Yield (%)	Parameter (No. of panicles m^{-2})		Change in Parameter (%)	Extension gap (q ha^{-1})	Technology gap (q ha^{-1})	Technology index (%)
	Demo	FP		Demo	FP				
2017-18	42.25	38.35	10.17	178	162	9.88	3.90	4.75	10.11
2018-19	42.60	39.20	8.67	179	164	9.15	3.40	4.40	9.36
2019-20	42.40	38.80	9.28	176	162	8.64	3.60	4.60	9.79
Average	42.42	38.78	9.37	178	163	9.22	3.63	4.58	9.75

Table 3: Economic analysis and water saving in demonstrated plots and farmers' practice

Year	Cost of cultivation (R ha^{-1})		Gross returns (R ha^{-1})		Net return (R ha^{-1})		B:C ratio		No. of irrigation (no.)		Depth of irrigation (ha-cm)		Irrigation water saved (%)
	Demo	FP	Demo	FP	Demo	FP	Demo	FP	Demo	FP	Demo	FP	
2017-18	30430.00	34570.00	77740.00	70564.00	47310.00	35994.00	2.55	2.04	2	3	22.35	31.20	39.60
2018-19	31340.00	35250.00	83922.00	77224.00	52582.00	41974.00	2.68	2.19	2	3	22.35	30.90	38.26
2019-20	31590.00	35680.00	91160.00	83420.00	59570.00	47740.00	2.89	2.34			22.10	30.80	39.37
Average	31120.00	35166.67	84274.00	77069.33	53154.00	41902.67	2.71	2.19	2.00	3.00	22.27	30.97	39.07

Conclusion

In the present scenario of rising inputs cost and labour shortage in agriculture, farmers need input saving alternative technologies to sustain crop production. In zero tillage wheat cultivation, both yield and net returns were 9.37 and 26.85 per cent higher than conventional wheat sowing. Similarly average 39.07 per cent irrigation water was saved in zero tillage. The increase in yield of wheat to the extent of FLDs over the conventional sowing created greater awareness and motivated the other farmers to adopt this latest wheat sowing technology. The beneficiary farmers of FLDs also play an important role as a source of information. The concept of frontline demonstrations may be applied to all farmer categories including progressive farmers for speedy and wider dissemination of the recommended practices to other members of the farming community.

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